New Command and Control (C^2) Initiatives

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This briefing summarizes three new Command and Control (C2) initiatives from DARPA's Information Systems Office (ISO) which will begin in FY98.

New C^2 Initiatives

- Advanced Cooperative Collection Management (ACCM)
  - PM: CDR Carol Thompson, USN
- Agent-Based Systems (ABS)
  - PM: Maj Douglas Dyer, USAF
- Command Post of the Future (CPoF)
  - PM: David Gunning

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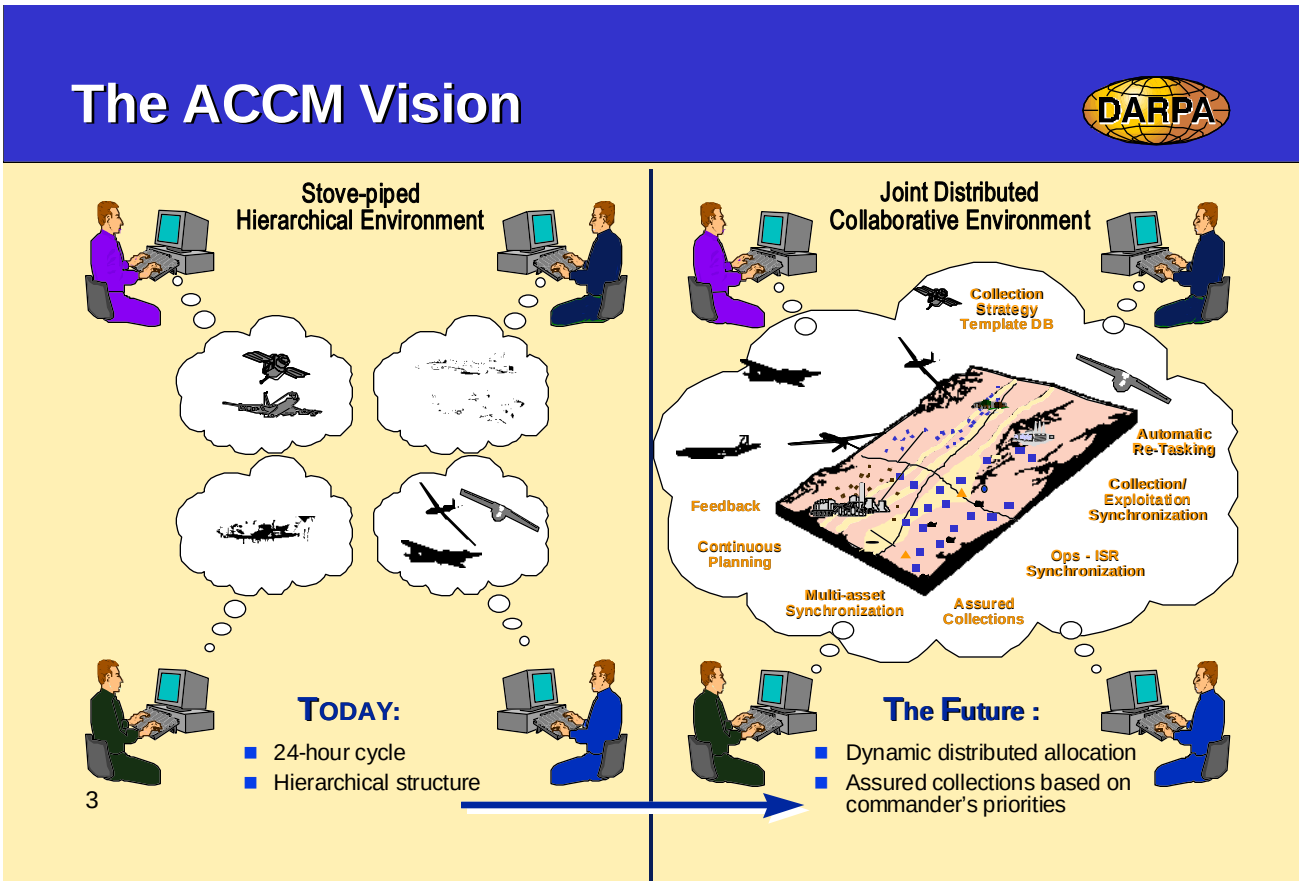
The three new initiatives are: (1) Advanced Cooperative Collection Management (ACCM) managed by CDR Carol Thompson; (2) Agent-Based Systems (ABS) managed by Maj Doug Dyer; and (3) the Command Post of the Future (CPoF) managed by David Gunning. The ACCM program issued a Broad Area Announcement (BAA) this summer. ABS and CPoF will issue a BAA during FY98.



Today's Intelligence, Surveillance, and Reconnaissance (ISR) collection management activities exist within a stovepiped, hierarchical environment that is not linked to the operational planning and execution cycles. ACCM will develop and transition the technologies necessary to foster a joint/ distributed collaboration environment for ISR collection management, collection, processing, exploitation, dissemination, and user feedback and establish the linkages to operational planning and execution. This revolutionary approach will allow the ISR confederation to respond in a time-compressed and cooperative collection capability that is necessary for dynamic allocation of ISR assets and assured collections based on the commander's operational priorities.

ACCM Program Goals

- **Tightly integrate** the ISR management process into operational cycles for optimal requirements satisfaction and response to real-time needs
  - **Drastically shorten** the operations planning to information product delivery timelines
  - Provide near-real-time, **focused information support** to warfighters
- **Revolutionize ISR management** by optimizing platform trajectories and sensor schedules such that prioritized targets/areas are viewed with the right sensor(s)/sensor modes, from the right viewing angle, at the right time
- Develop and **transition enabling technologies** to conduct dynamic collaborative, continuous asset planning, automatic re-tasking, and multi-asset synchronization across multiple echelons

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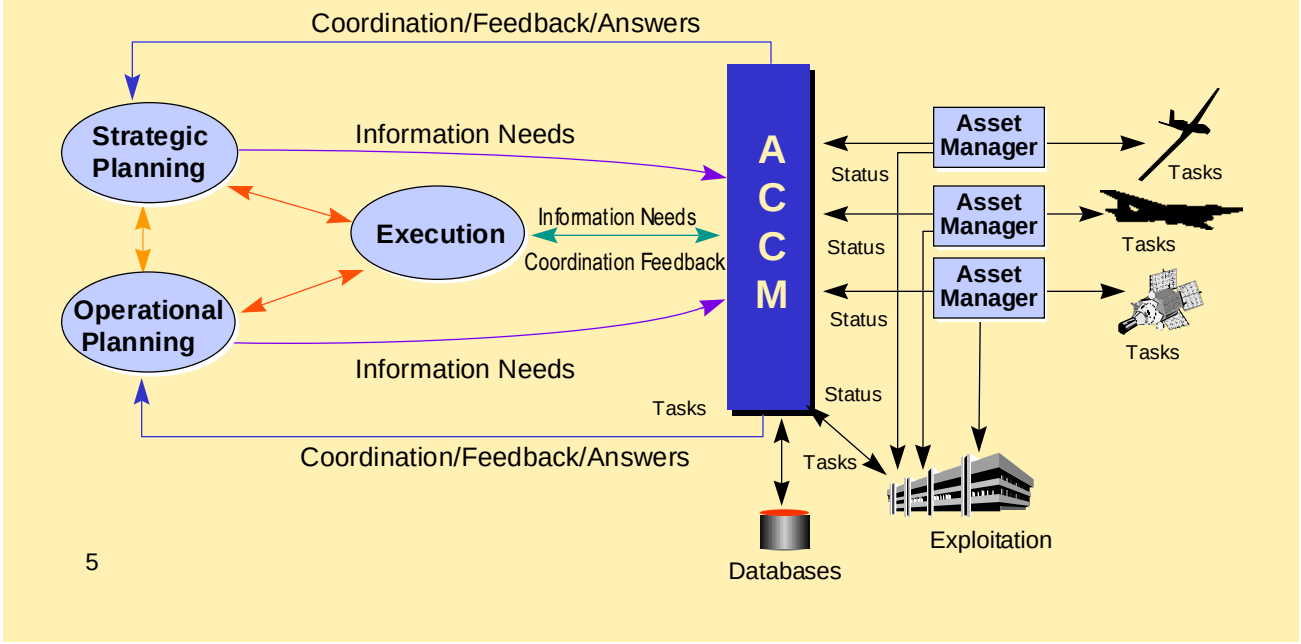
The goal of the ACCM Program is to develop and transition capabilities that will allow the ISR confederation to operate in a time compressed and cooperative collection capacity necessary for synergistic collections, time critical targeting, and dynamic battlefield awareness. The program is initially focused on supporting the Joint Task Force (JTF) and its component command structure.

Activities essential to this goal include the management of information system processes, development of strategies for the optimization of the ISR confederation, and the development of technologies and processes for multi-asset synchronization.

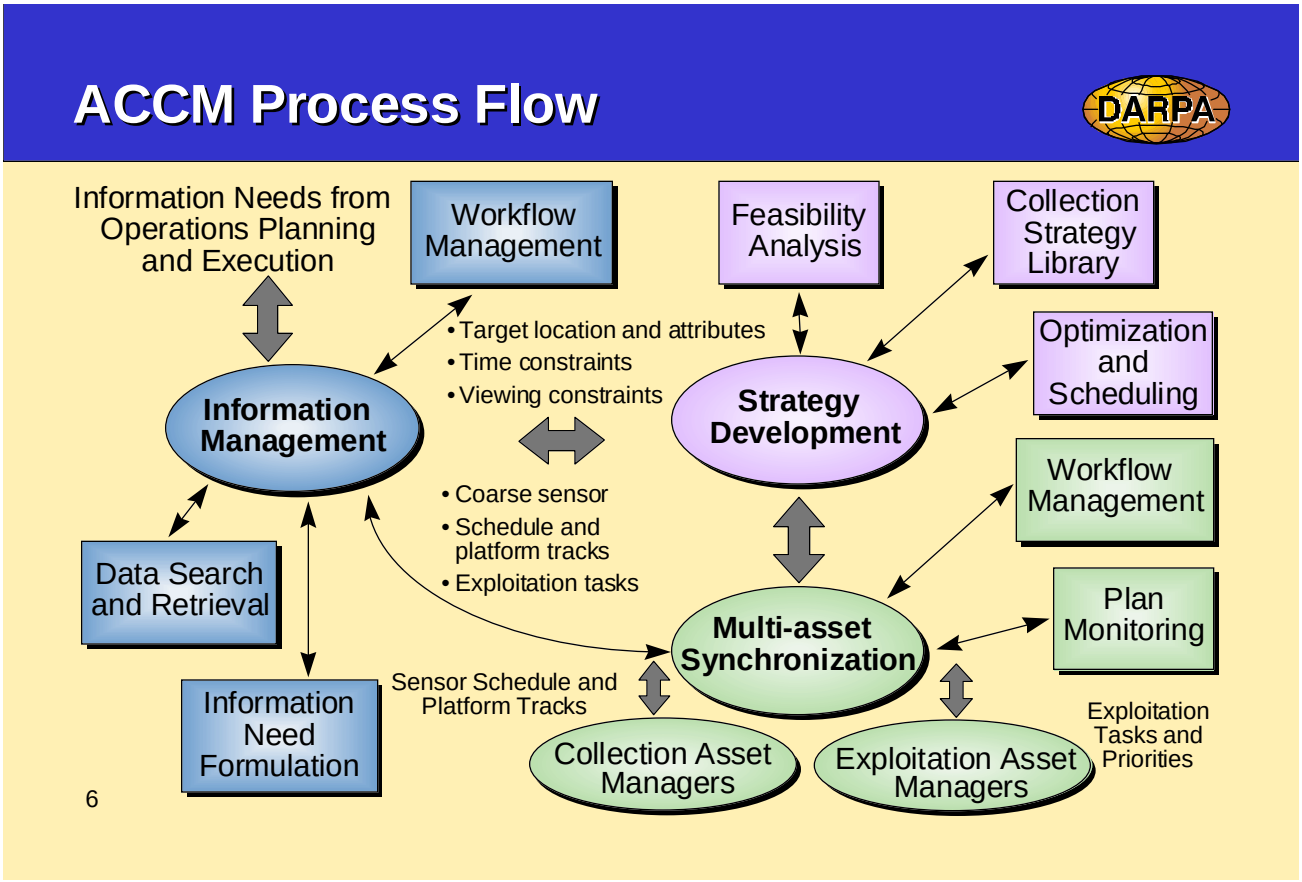
Technologies and processes developed under AIM may be transitioned into the Defense Intelligence Agency's (DIA) Integrated Collection Management Advanced Concept Technology Demonstration (ICM ACTD), the Joint Collection Management Tool (JCMT), DARPA's JFACC program, and individual operations management and ISR programs where applicable.

ACCM Concept of Operations



Information dominance within the dynamic battlefield demands that the ISR confederation provide the necessary information to the correct operational echelon within required timelines. Consequently, the ISR management process - from information need generation, to tasking, collection, exploitation, and dissemination - must be tightly integrated into the operational cycles and optimized for requirements satisfaction and responsive to real-time needs.

ACCM will develop and transition tools and processes to allow the Joint Task Force Commander to gain more flexible and dynamic access to all collection assets (national/tactical/theater) for planning and executing a fully integrated intelligence/operations plan.



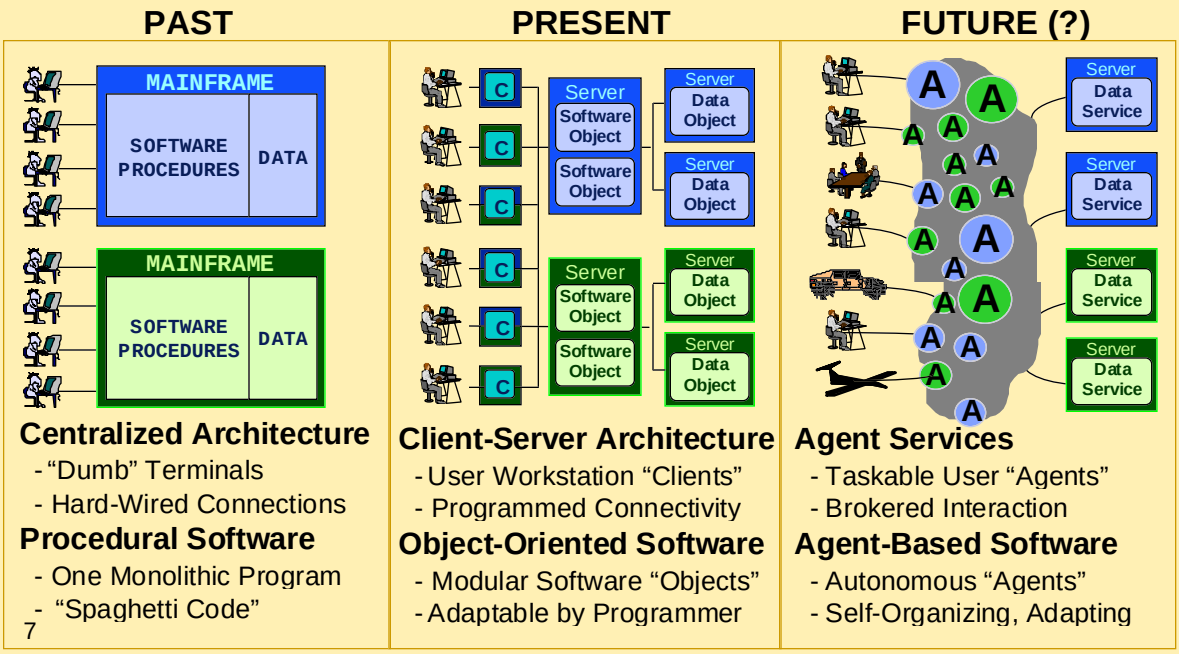
ACCM will concentrate on three major areas to achieve its goal:

1. Information Management: ACCM will develop and transition technologies and processes for (1) continuous interactive feedback to the requester on the status of the information need satisfaction; (2) coordination between strategic, operational, and ISR planning; (3) generation of subordinate priorities for support; and (4) computer-aided management of information needs.

2. Strategy Development: ACCM will develop and transition technologies and processes to (1) decompose information needs into technical specifications for tasking based on user priorities; (2) conduct performance analysis to determine strategies for maximum military utility for the ISR confederation; (3) develop alternative strategies for tasking and determine the feasibility of these strategies; and (4) compose optimal, timely deployment and execution strategies to include platform trajectories, sensor schedules, and exploitation loading.

3. Multi-Asset Synchronization: ACCM will develop and transition the capabilities to (1) synchronize collection, exploitation, and fusion of information to optimally satisfy selected strategies; (2) determine the feasibility of tasking through the continuous coordination with ISR assets; and (3) provide coordination and feedback within a collaborative operations environment.

Agent-Based Systems (ABS)



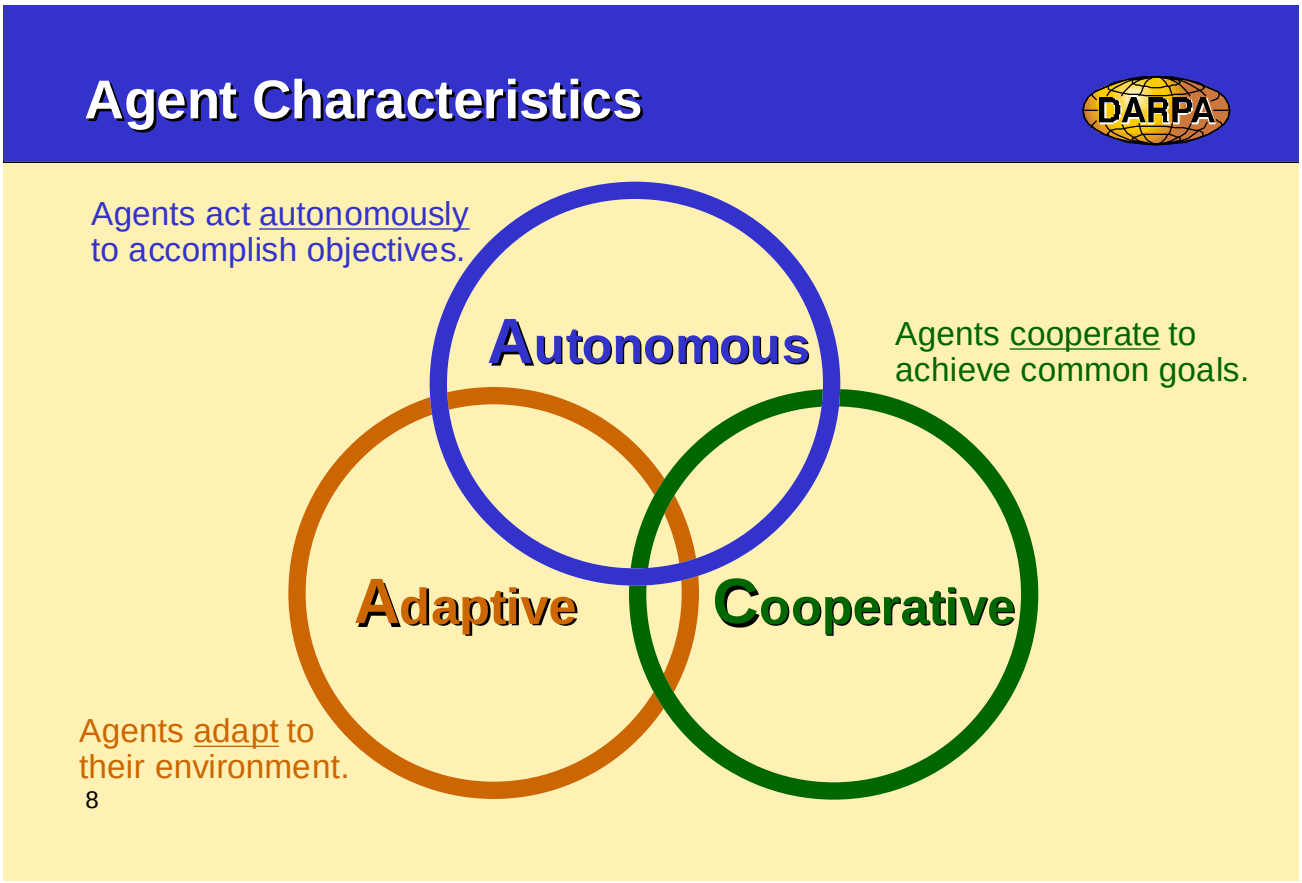
The second new initiative is the Agent-Based Systems (ABS) program, managed by Maj Doug Dyer.

In the past, we've had centralized computer architectures, terminals and mainframes which were essentially disconnected. Our software was mostly procedural and often unstructured.

Currently, most enterprises rely on a client server architecture and local area networks. Developers have adopted object-oriented methodologies to reduce programming costs, but costs remain high.

The shift to client server architectures was driven by our need to access information, but now we have so much access to information that we are overwhelmed by the drudgery of sorting it all out. Very quickly, we will have to adopt a new model of computing that includes intelligent agents which act on our behalf to provide services we need.

We don't want raw data, we want specific information for making decisions. We don't want to have to deal with details that the computer should be able to figure out. And we certainly don't want to continue to pay high software modification costs to make it work in slightly different situations.



Intelligent agents have diverse characteristics, but three that we think are important are shown here.

To be useful, agents must have some level of autonomy, just as subordinates in an organization do. If you want an agent to act on your behalf, it must have the authority to do so.

Although some agents are independent, we believe the major contribution of agent systems will arise from a set of agents collaborating to achieve goals.

Furthermore, we believe adaptation is important. Adaptation provides the flexibility to alter behavior beyond that scripted by a programmer. Adaptation might be embodied by a learning algorithm or it might only include methods for planning around unforeseen problems.

Program Goals

- Develop effective strategies for controlling large agent-based systems
  - Exploit synergy from multi-agent collaboration
  - Increase ability to build complex systems
  - Avoid undesirable behavior
- Develop supporting technology necessary to implement those strategies

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Although agent-based systems pose many potential benefits, control of these systems is required to avoid possible problems. Our goals to exploit the advantages of agent-based systems depend on our ability to develop and implement effective control strategies.

Alternative Agent Control Strategies

Knowledge-Sharing

- Agents share knowledge about capabilities and requests.
- Agent *brokers* dynamically match requests to capabilities.
- System dynamically adjusts changing conditions.

Team Coordination

- Agents share knowledge about goals, plans, tasks & subtasks, commitments and performance.
- Teams cooperative through partially synchronized actions to accomplish common goals.

Market Economy

- Self-interested agents pursue personal profit.
- *Behavior is driven by the cost of* resources.
- Agents are controlled by specifying rewards and penalties.

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Evolutionary

- Agent populations evolve over time through "reproduction," mutation and natural selection.
- Agents are controlled by specifying selection criteria and reproduction process.

Some of these strategies are shown here.

Knowledge sharing is a dominant control method for many of the information management agents we have begun to see. An example is MCC's Infosleuth.

Team coordination is a common strategy for multi-agent collaboration. Many of the agents developed at universities use this strategy.

Capitalism suggests another control strategy called the market economy. In this strategy, individual agents pursue their own selfish interests but synergy arises because of costs and benefits assigned.

The evolutionary strategy depends on natural selection for its control method. Artificial life experiments are an example of this strategy.

Program Approach

- Explore and test alternative agent control strategies
- Develop agent construction tools
- Define agent interoperability standards
- Demonstrate agent-based solutions for military problems

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We anticipate these steps to execute our program.

Command Post of the Future

- **Battlespace Theater**
  - High Resolution Displays
  - Electronic Sand-Table
  - Speech & Gesture Interaction
  - Natural Language Queries
  - Collaboration Support
- **Information Center**
  - Staff Anchor Desks
  - Interfaces to C4I Applications
  - Information Integration Tools
  - Decision-Centered Retrieval
  - External Connections

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The third new initiative is the Command Post of the Future, managed by David Gunning.

The goal of the CPoF Program is to provide the commander and his staff with an environment to rapidly visualize, analyze, and understand the battlespace. Current technology is flooding the commander with messages, images, and data which require increasing numbers of people and computers to process, interpret, integrate, and understand the incoming information streams. In order to facilitate the Commander's visualization of the battlefield, we will develop/integrate advanced concepts for a Command Post which will exploit recent advancements in human computer interaction technologies incorporating interactive 3D visualization, interactive 3D techniques, uncertainty presentation, temporal presentation, 3D symbology, Natural Language (NL) processing, and Knowledge Base (KB) querying technologies. This system will additionally provide for collaborative planning using on-screen teleconferencing, shared map planning and electronic white boards.

Battlespace Understanding

- Immediate Understanding
  - Data => Information => Knowledge
  - Intuitive visual presentation
- Decision-Centered
  - Show decision-relevant details
  - Seek out relevant changes, anomalies, exceptions
  - Uncover battlespace patterns
  - Portray uncertainties
- Easy Exploration
  - Intuitive manipulation, interaction
  - Question answering, explanation

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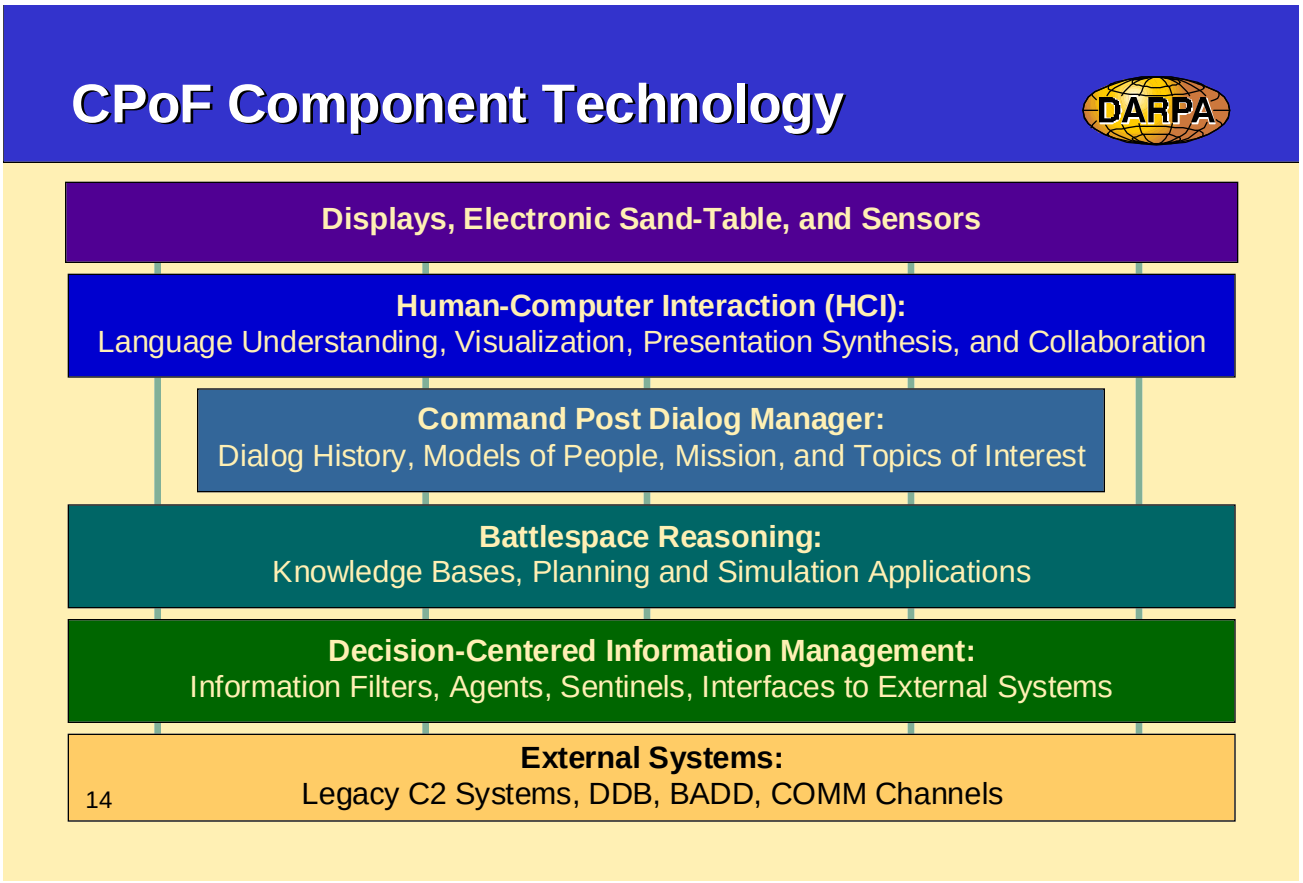
The CPoF system will provide the commander information about the battlespace in a form that will enhance his cognitive processes. Decreasing the uncertainties, unknowns, and the fragmented pictures of the battlefield, while enhancing the Commander's ability to make decisions and direct their execution in an environment of great uncertainty. In building and maintaining situation awareness the system must avoid simply increasing the quantity of data provided to the commander. The system will provide information by exception rather than as the norm in a graphical form, where appropriate, to assist the Commander in finding critical vulnerabilities, project trends, and development of decision centered solutions.



The component technology for the Command Post of the Future is expected to include: high resolution displays including an electronic sand-table; a suite of HCI, visualization, and collaboration tools; a dialog management component which would keep track of the on-going dialog between the commander and his staff, the people in the Command Post, their roles and topics of interest; a battlespace reasoning layer to include a knowledge base of concepts and terms used in the dialog and interfaces to analysis, planning, and simulation tools; and a decision-centered information management layer which would consist of information gathering agents and sentinels which would seek out and filter information for the commander and his staff which is relevant to the decisions of interest.

CPoF Development Strategy

- Conduct User Experiments
  - Build an experimental CPoF environment
  - Evaluate HCI and Visualization Alternatives
  - Develop System Design for Initial and Final Prototypes
- Develop an Initial (2-Year) Prototype
  - Basic Visualization Environment
  - Demonstrate Marine and Army Exercises
- Develop a Final (4-Year) Prototype
  - Expand Initial Prototype to Full Capabilities
  - Demonstrate in Marine, Army, and Joint Exercises

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The development plan for the CPoF is (1) to conduct a continuous series of experiments with operational users to determine the human-factors and information requirements for the CPoF; (2) to develop an initial (2-year) CPoF capability using near-term technology, to include large screen projection displays, non-stereoscopic table displays, simple speech commands, battlefield visualization with semantic zooming and 2D graphics synthesis, and information integration; and (3) to enhance the baseline system by developing and incorporating advanced technology, such as interactive 3D visualization, stereoscopic displays, full natural language understanding and knowledge-based query capability, and decision-centered information management.